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(54) METHOD FOR MAKING A RADIAL PLY TIRE IN A SINGLE BUILDING STAGE

(71) We, UNIROYAL INC., of 1230 Avenue of the Americas, New York, NY 10020, United States of America, a corporation organized under the laws of the State of New Jersey, one of the United States of America, and UNIROYAL, of Clairoix (60), Oise, France, a corporation organized under the laws of France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method for making radial ply tires of the type including bias-angled breaker plies and a 0° cap band and more specifically to a method for making such a tire in a single building stage and to an intermediate article of manufacture resulting from the method.

The expressions "radial tires" and "radial ply tires" as commonly used in the pneumatic tire art may be said to include various tire constructions having a body comprising one or more reinforcement plies of rubberized tire cords extending from bead to bead wherein the cords in each ply are substantially radial in orientation, i.e., the cords are oriented substantially normal to the beads and to the crown centerline of the tire. In a mono-ply radial tire the body cords normally have 90° bias angle, i.e., in the unshaped carcass they extend perpendicular to the planes of the beads. In a two-ply radial tire, the cords in each body ply are usually oriented at oppositely disposed small angles of up to 10° with respect to the perpendicular to the bead planes, in which case the respective body plies are said to have oppositely disposed bias angles of 80° or greater (but less than 90°). In four-ply or heavier radial ply tire constructions similar opposed orientation of the cords in successive body plies is usually employed. All of these body constructions are contemplated within the scope and meaning of the expression "radial" and "substantially radial" as used herein.

Radial tires are generally constructed with a breaker or belt interposed between the crown region of the carcass and the tread for reinforcing the latter, such breaker being comprised of one or more layers or plies of tire cords or cables which are generally inextensible, i.e., made of such materials as metallic wires, glass fiber, rayon or nylon. In a mono-ply belt, the cords or cables have a relatively low bat angle of 0°, i.e., they are oriented substantially parallel to the planes of the beads and to the median equatorial plane, or crown centerline, of the tire. If the belt is of a multi-ply construction, similar but opposed low bias orientations of the cord or cables generally at angles ranging up to about 30° or so with respect to the median equatorial plane of the tire are employed in successive plies. The more recent of such tires further include a 0° cap band, i.e. with cords parallel to the median equatorial plane, positioned radially outward of the breaker structure and beneath the tread which cap band serves to enhance both the geometrical uniformity and the rolling properties of the tire.

In the building of radial ply tires having breakers and 0° cap bands incorporated in the crown area of the tire, a two stage process is conventionally employed. During the first stage of building, a cylindrical tire body is formed, the body having one or more rubber covered cord plies anchored to and interconnecting axially spaced, parallel, coaxial bead cores, and a layer of rubber sidewall stock on each side-wall area of the body intermediate the eventual crown area thereof and the two bead areas thereof. Such an assembly is conventionally referred to as a "first stage" carcass. During the second stage of building, the shape of the first stage carcass is changed from cylindrical to toroidal, and one or more rubber covered cord breaker plies, the cap band and a rubber tread band are added to the crown portion of the tire carcass to form what is conventionally referred to as a "second stage" carcass. The term "rubber"

as used herein is intended to cover natural and synthetic rubber and rubber-like materials as well as blends thereof. The term "cord" as used herein is intended to cover single and multiple strands, filaments, wires or cables of natural and/or synthetic textile materials such as cotton, rayon, nylon, polyester, glass fiber and nylon, metal, and/or such other materials as may be used as reinforcements in pneumatic vehicle tires.

As above stated, the shape of the first stage carcass is changed during the second stage of building from cylindrical to toroidal, and breaker plies, the cap band and a rubber tread band are added to the tire carcass to form the aforementioned second stage carcass. Machines of the type presently known in the art for building tires frequently utilize two stations to perform this function. The first station is utilized to fabricate the breaker, cap band and tread assembly by successively winding the various elements thereof about a radially expansible and contractible building drum. The breaker, cap band and tread assembly is then conveyed from the first station to the second station at which is positioned the aforementioned cylindrical carcass, the second station including support and shaping disks and movable conical shaping rings engageable with the carcass sidewalls for shaping the first stage carcass into the second stage carcass during inflation thereof. The breaker, cap band and tread assembly is then positioned so as to encircle the eventual crown area of the first stage carcass which is positioned on the aforementioned support and shaping disks. The carcass is then inflated and the crown area thereof expands into pressurized contact with, and adheres to, the inner surface of the breaker, cap band and tread assembly to form the desired second stage carcass. The second stage carcass may now be deflated and removed from the support and shaping disks. This two-stage building method has been necessitated by the fact that any low bias angle breaker plies built into the unformed tire on the drum would necessarily have to be stretched considerably in circumference during the forming of the tire. While some of this stretch can be accomplished, as in the forming of the body plies of conventional tires, by the cords in the breaker plies assuming a more nearly circumferential orientation and moving closer together, some of it is necessarily, because of low bias of the breaker plies, accomplished by the parallel slippage as well as the pivoting action of the cords in the breaker plies. When, in the past, it has been attempted to form completely drum-built radial tires containing low angle breakers, it has been found that the adhesion of the breaker ply cords to the adjacent tire components resulted in uneven movement of the cords and consequent malformation of the tires. In the case of such tires which include 0° cap bands, the problem has, of course, been compounded by the fact that, since the cords comprising the cap band are already substantially at 0° relative to the median equatorial plane of the tire, there can be no slippage or movement toward a circumferential orientation and because the cords of the cap band are inextensible, they cannot stretch to accommodate the expansion of the carcass.

Although tire making machines of the type presently known in the art are efficient and produce uniform, high quality, second stage carcasses, it would be desirable, for economic reasons, to be able to build such tires in a single stage process. The desired economics would result from, among other reasons, the ability to use existing single stage building equipment, the fact that a lesser amount of expensive factory floor space would be required for the necessary tire building equipment, and the fact that fewer man-hours would be required for the building of a tire in a single stage.

According to the present invention a method for making a radial ply tire in a single building stage comprises winding at least one ply of body tire cords around a tire building drum to form a cylindrically shaped body with said body tire cords extending substantially parallel to the axis of said drum; serially wrapping an even number of plies of bias angled breaker tire cords around the radially outer surface of said body to form a breaker, the breaker tire cords in each ply being parallel and the cords being oppositely disposed in adjacent plies and forming an angle of between 30° and 70° with a plane orthogonal to the axis of said drum; helically winding a "soft-stretch" reinforcing cord tape (as herein defined) around the radially outer surface of said breaker for at least a selected plurality of full turns to form a cap band having a desired axial width, said tape being wound at an angle of substantially 0° relative to the plane orthogonal to the axis of said drum; and wrapping tread and sidewall rubber around the radially outer surface of the cap band and the lateral region of said body so as to provide a raw, cylindrically shaped, tire carcass having a diameter which is substantially less than the diameter of the crown region of the corresponding cured, toroidally shaped, completed tire.

The present invention may also be characterized as an intermediate article of manufacture; namely an uncured, radial ply tire carcass in the as drum-built from thereof comprising a cylindrically shaped body including at least one ply of body tire cords, which tire cords extend substantially paral-

lel to the axis of the cylindrically shaped body; a breaker positioned circumferentially about said body, said breaker including an even number of plies of bias angled breaker tire cords, said breaker tire cords in each ply being parallel and the ends being oppositely disposed in adjacent plies and forming an angle of from 30° to 70° with the plane orthogonal to the axis of the cylindrically shaped body; a cap band positioned circumferentially about said breaker, said cap band being formed by "softstretch" reinforcing cord tape (as herein defined) helically wound around the radially outer surface of the breaker for at least a selected plurality of full turns, said tape being wound at an angle of substantially 0° relative to the plane orthogonal to the axis of the cylindrically shaped body, an tread and sidewall rubber positioned circumferentially about said cap band, and the lateral regions of said body.

The present invention will be more clearly understood from the following detailed description of particular embodiments thereof, given by way of example only, when read in conjunction with the accompanying drawings, in which:

Figure 1 is a partially sectioned perspective view of a raw, cylindrically shaped tire carcass, in its as-built form, on a building drum, made in accordance with the method of the present invention;

Figure 1A is an enlarged, partially sectioned, perspective view of a portion of the carcass illustrated in Figure 1;

Figure 2 is a sectional plan view of the intermediate article tire carcass of the present invention illustrated in Figure 1 and taken along lines 2—2 thereof;

Figures 2A and 2B illustrate modifications of the tire carcass illustrated in Figure 2;

Figure 3 is a fragmentary, diagrammatic, perspective view of a six-cord "soft-stretch" tape used in the manufacture of the tire carcass illustrated in Figure 1 according to the method of the present invention; and

Figure 4 is a partially sectioned perspective view of a cured, toroidally shaped, completed tire made according to the method of the present invention.

Referring now to the drawings, wherein like reference numerals denote corresponding parts throughout the several views, Fig. 1 illustrates a partially sectioned perspective view of a raw cylindrically shaped tire carcass 1 in its as-built form on a low diameter building drum 3. The method for making a radial ply tire in a single stage is, in the initial stages of the building operation, generally conventional. The first step is to wind at least one ply, and preferably two plies, 5 and 7, of body tire cords, which cords extend substantially parallel to the axis, indicated at A—B, of the drum 3, around the drum about which a rubber liner 9 (Fig. 2) has been wrapped, to form a cylindrically shaped body. The tire building drum 3 is of the type conventionally used in the tire building art for first stage tire building. The associated body components such as the bead cores, chafer and apex strips, indicated generally at 11 (Fig. 4), are also assembled on the building drum which may be of the expandable and contractible type and may be either a flat drum or a shoulder drum. The term "low diameter" is here used with respect to the drum to signify that the diameter of the drum, and thus that of the generally cylindrical carcass built thereon, is appreciably smaller than the final diameter to which the tire wall be radially expanded when being shaped into its desired toroidal from as an adjunct of the curing operation in the mold. The next step is to serially wrap an even multiplicity, of, for example, two, plies 13 and 15 of biased angled breaker tire cords which may, for example, be of steel, which is substantially inextensible around the radially outer surface of the body to form a breaker structure 16. The breaker tire cords are parallel to one another in each ply and are oppositely disposed in adjacent plies, and the angle they form relative to the plane orthogonal to the axis A—B of the drum 3 is between 30° and 70°, and, in the embodiment illustrated, is 40°. The next step is to helically wind a strip of "soft stretch" reinforcing cord tape 17 (Fig. 3) around the radially outer surface of the breaker structure for at least a selected plurality of full turns to form a cap band 19 having a desired axial width. The tape 17, which is longitudinally extensible by between 30% and 75% without stretching the cords thereof, is wound at an angle of substantially 0°, i.e. not more than 2°, relative to the plane orthogonal to the axis of the drum.

An example of the "soft-stretch" tape 17 which is used to form the cap band 19 is illustrated in Fig. 3 as a six-cord "soft-stretch" tape. In the present specification, by "soft-stretch" reinforcing cord tape is meant tape comprising one or more cords extending longitudinally of the tape and each having formed therein a multiplicty of substantially planar undulations, the undulations preferably being of a generally sinusoidal nature, the term "soft stretch" denoting the ability of the tape to be longitudinally extended a predetermined amount by the straightening of its component cord or cords without the latter being stretched. The tape 17 includes the required number of individaul cords 21, each of which may be untreated or may have a coating of rubber or latex or other rubber-adhesion promoting material applied thereto and is made so that the final tape has the desired

stretch ratio (the ratio of straightened cord length to unextended tape length). A relatively weak and frangible cotton or like yarn or thread 23 holds each of the cords of the tape in its undulating state and, where the tape 17 includes a plurality of cords 21, more than one of these cords may also be tied to each other by the stitches 23. In a preferred version of such a plural-cord tape used to form cap band 19, the cords 21 are disposed side by side with the undulations of laterally adjacent cords in parallel planes and out of phase with one another. To enhance the stability and integrity of the tape a second relatively weak and frangible cotton or like thread or yarn (not shown) may also be woven into and held by the aforementioned stitches. This second yarn, which extends the length of tape is, however, in almost a straight condition, with only minimal undulation. Each cord may also be provided with a multiplicity of longitudinally spaced locally weakened portions to enhance its ability to be stretched and elongated somewhat after being fully straightened. The weakening of the cord portions, which may be effected mechanically, chemically or otherwise is accomplished in such a manner as to leave the portions with a relatively low residual tensile strength, generally on the order of about 5% to 20% of their pre-weakened or full tensile strength. For the production of any given tire, the weakening interval, i.e., the cord length between successive weakened portions is selected and preset to be different from, but not equal to a rational fraction of, the ultimately intended circumferential length of a full turn of the cap band 19 in the finished tire.

The tapc winding operation may be either unidirectional or bidirectional with reference to the axis of the building drum and the winding is continued until the tape-constituted cap band structure extends over the desired width of the medial region of the cylindrical carcass. It will be understood that the tape 17, once properly laid on the breaker 16, will not twist or shift out of its wound-on position, and the use of a tape of plural-cord width will enable a relatively large number of cords to be applied with each turn of the tape.

It should be noted, merely by way of example, that it has been found that for most standard rim size 0° cap band passenger tires which are completely built in a flat band form in a single stage building operation prior to being shaped, a tape having a stretch ratio of between 1.5 and 1.9 (50% and 90%) provides satisfactory results. It will also be understood, however, that for certain types of tires the building operation may dictate the use of a tape having a stretch ratio which may be as low as about 1.2 (20%), while for other types the stretch ratio may have to be as much as 4 (400%).

Prior to winding the tape strip 17 helically around the breaker 16 which has been wound onto the body layer, the breaker cords are stitched down (adhered) in the axially central portion of the breaker. It has been found advantageous to stitch the breaker down in the area of one inch (1") on each side of the axial center line thereof so as to prevent shifting of the breaker 16 during the pantographing of the cords therein which occurs during the shaping of the cylindrical carcass into the toroidal tire.

The raw, cylindrically shaped tire carcass is now completed by wrapping a tread and sidewall rubber band 25 around the radially outer surface of the cap band 19 and the lateral regions of the body, and the splices in the band 25 are stitched (adhered) under conditions insuring that no undesired bunching of the cap band turns will occur. Thereupon, the raw or green tire in its as built form is removed from the building drum and is ready to be subjected to the final shaping and curing operation.

When a 0° cap band raw tire built by the above described method is radially expanded and axially contracted into its final toroidal shape (either in the curing press or prior to its being put thereinto), the cap band forming structure defined by the wound on tape is, of course, subject to the same type of radial expansion. This expansion almost immediately causes the weak stabilizing or stitching threads or yarn 23 to be broken and they then have no further function in either the process or the tire, although of course they remain in the tire. Thereupon, as the expansion of the tire continues, the cords 21 lose their undulations and are ultimately completely straightened out to define the cap band 19.

In this connection it should be noted that whether the tire is to be cured in a segmented mold, in which case the cap band expansion will be substantially completed before the mold is closed, or whether the tire is to be cured in a standard unsegmented "clam-shell" mold, in which case a small further expansion will take place after the mold is closed, the "soft stretch" tape used may have a stretch ratio as nearly as possible exactly equal to that actually required for the full radial expansion. Preferably, however, the tape 17 used will normally have a stretch ratio somewhat less than the full expansion ratio, in the order of between about 1% and about 3% less, so that the cord 21 becomes fully straightened and the undulations disappear thereform shortly before the shaping operation is completed. In such a case, of course, during the final expansion of the tire, e.g., upon the forcing of the tire against the mold

surfaces under high internal pressure after the mold is closed, the cap band cords will be subjected to fairly high tensile stresses and elongate to the extent required. Where the cords, by virtue of the construction and the stress-strain characteristics of the cord material, can accommodate the resultant strain and elongation without exceeding their elastic limit, the fact that they may be unweakened will not lead to any problems. Where, on the other hand, the cords are locally weakened, they will additionally have an increased ability to undergo a "hard stretch" without adverse effect, i.e., they will be able to elongate either, for example, by the strain of the cord material or by actually breaking at one or more of the locations of the various weakened portions thereof, or by a combination of these and similar characteristics. The weakening of the cords of the tape 17 at a multiplicity of longitudinally spaced points as described thus can be seen to provide a margin or safety, due to the presence of which a possible choice of a tape stretch ratio somewhat lower than the tire expansion ratio can be compensated for and thus tolerated.

By helically winding the longitudinally extensible tape 17, the final cap band 19 is devoid of splices, the absence of which splices leads to a greater degree of uniformity and dynamic balance in the finished tire. Moreover, the 0° belt or cap band leads to another advantage, that is, a maximized hoop modulus of the tire in the circumferential direction relative to the hoop modulus which a tire utilizing only biased belts directly under the tread would have.

Although a cap band 19 having an axial width less than that of the underlying breaker, comprised of plies 13 and 15, may be utilized it is known that many types of tires, especially radial ply carcass tires in which the tread is, as herein, reinforced by a breaker 16 composed of superposed, mutually crossed, rubberized plies of parallel substantially inextensible cords or cables, often fail at high speeds because separations occur in the shoulder zones 27 (Fig. 4) of the tires where the edges of the breaker plies are located. Such ply separations are due to the cord ends at the edges of the breaker plies 13 and 15 becoming detached from the surrounding rubber under the combined effect of centrifugal force acting on the tire, flexing of the tire and heat build-up in the tire. This result is made even more likely where, as here, the cords or cables in the breaker plies, 13 and 15, which are disposed obliquely to the median equatorial plane of the ultimately toroidally shaped completed tire, have, by virtue of the plies being cut obliquely with respect to the longitudinal direction of the cords therein, a natural tendency to spread apart at their cut ends. The edges of the breaker plies 13 and 15 thus constitute zones where the cut and free ends of the reinforcing elements, that is, the cords or cables, by friction and by cutting, cause breaks both in the carcass plies 5 and 7 and in the rubber of the tires. Where the tires which result from the method and raw carcass disclosed herein are to be utilized in high speed service it is advantageous to form the cap band 19 so that its axial width is at least as great as, and preferably greater than, the width of the breaker 16. Such a construction will enable the 0° cap band 19 to minimize the detrimental ply edge separation.

Due to the fact that tapes of the type herein described and utilized are not conveniently made with more than about 4 or 5 cords 21 therein, when it is desired to utilize in the building of the cap band 19 of the instant invention a tape 17 having a relatively high number of component cords 21, such a tape 17 may be made of a plurality of tapes of lesser cord numbers, with these lesser cord tapes being cemented or otherwise adhered to one another in a side by side relation. In this regard it is appropriate to note that if such a side by side relation of low number cord tapes is utilized, it is advantageous to offset the low number cord tapes relative to one another so as to cause the undulations of the respective adjoining side cords to be out of phase with one another.

As shown in Fig. 2 the tape 17 forming the cap band 19 is preferably wound with the turns of the band forming structure spaced slightly from each other by a gap 29 of predetermined width, the reason for which will be discussed below.

It will be understood, of course, that in order to achieve the stated orientation of the tape turns, that is in a direction as nearly orthogonal to the axis A—B of the drum and the carcass as feasible, and thus as close to the truly circumferential direction as possible, it is necessary to insure that the helix or winding angle of the tape be as small as possible. For the purpose of the present invention this means the helix angle is substantially 0°, i.e. it may not be greater than 2° and is preferably less han 1°. The magnitude of the helix angle will basically be a function of, on the one hand, the width of the tape indicated at 31, plus the width of the gap 19 between two adjacent turns of the tape, and of, on the other hand, the diameter of the drum 3, these parameters defining, respectively, the lead of the helix and the length of one turn of the tape around the circumference of the drum. Thus, for example, a tire built on a 15″ diameter drum and including a cap band forming structure utilizing a rubber coated rayon cord six cord wide tape, the

width of which is approximately 0.3", wound "on end" with a gap of approximately 0.1", will having a winding angle of approximately ½°, this angle being the arc tangent of the quotient of the lead of the helix divided by the circumference of the drum, i.e., approximately 0.0085.

It is further deemed advisable to effectively skive the tape at the opposite lateral edges of the band forming structure so as to minimize any possible discontinuity in the rubber to cord stress transfer in the ultimate finished tire. This result is accomplished by peeling away and cutting off at each end of the tape a predetermined length of the end region of the laterally outwardly facing tape component.

Turning once again to the spacing 29 between the tape windings it will be remembered of course that the cylindrical carcass will be radially expanded into a toroid. During the shaping operation the cords straighten out and the cap band forming structure becomes somewhat narrower. It will be apparent, therefore, that it is to facilitate this narrowing and at the same time prevent the cords from bunching up at indeterminate locations across the width of the cap band that the winding cap between the turns of the tape in the cap band forming structure is provided. The width of the gap is, of course, predetermined and selected to yield the desired cord density in the final band without unduly increasing the helix or winding angle. Nevertheless, it should be understood that the gap may be either entirely omitted or not specifically controlled to be uniform throughout if some bunching of the cords and the resultant non-uniformity of the band 19 can be tolerated. Further, it will be understood that gaps as large as three-quarters of one inch, and even slightly larger, depending on tire size and tape width, may be utilized. Thus, a tire as small as one built on a 13" diameter drum and including a tape as wide as a nine cord wide tape, the width of which is approximately 0.45", would have a winding angle, if a three-quarter inch gap were utilized, of 1.7°.

It will be understood that although only a mono-ply cap band has been illustrated, a multi-ply cap band 19 may be provided. This may be accomplished, for example, by, after a desired axial width cap band 19 is provided by means of the above described helical winding of the tape 17, continuing to wind the tape back onto itself at the same helix angle. An alternative method is to sever the tape 17 after a cap band 19 having a desired axial width is generated and to begin the winding process again, the second ply being, of course, radially outward of the first ply. Yet another method of providing a muluti-ply cap band is to utilize a multi-ply or "nested" tape, i.e., a tape in which a multiplicty of cords are arranged so that the undulations of each cord are interfitted with, and lie in the same plane as, the undulations of each adjacent cord, and to helically wind this multi-ply tape a single time. The cap band 19 which results from this last method will have a number of plies equal to the number of layers of the nested tapes.

The next step in the method to arrive at the structure shown in Fig. 1 is the wrapping of the tread and sidewall rubber head 25 around the radially outer surface of the capband 19 and the lateral regions of the body. This results in a raw, cylindrically shaped, tire carcass 1 having a diameter which is substantially less than the diameter of the crown region of the corresponding cured, toroidally shaped, completed tire 33, shown partially sectioned in Fig. 4.

The final step in the method for making the desired radial ply tire is the step of simultaneously shaping and curing said raw, cylindrically shaped, carcass 1 to form the completed tire 33. It will be understood of course that although the steps of shaping and curing were indicated as occurring simultaneously, in actuality the shaping step begins as the curing mold is closed onto the cylindrical shaped carcass 1 whereas the curing step does not commence until after the shaping of the tire has commenced. Nevertheless these two steps, which both occur in the curing mold are so closely related in time that, for the puropses of this invention, they may be considered to occur simultaneously. It will be understood of course that this essentially simultaneous shaping and curing need not occur. Thus, the tire may be shaped in a completely separate step by using conventional shaping means. In this event only a small portion of the total shaping will occur during the curing operation, and then only if a non-segmental "clam-shell" type mold is utilized.

Turning now to Fig. 1A there is illustrated an enlarged partial view of the completed raw carcass illustrated in Fig. 1. In this view, more clearly than in Fig. 1, it may be seen that the tape 17 includes six adjacent cords 21, the tape being, as noted above, made up of two three-cord high or wide tapes. The gap 29 between each of the tapes 17 may be more clearly seen in the view as may be the stitching yarns 23 which, as previously noted, serve to maintain the cords 21 in position relative to one another until the tire is shaped.

Turning now to Fig. 2 there is shown a sectional plan view of the intermediate article tire carcass of the present invention. This carcass is, of course, the carcass 1 illustrated in Fig. 1 after the removal thereof

from the expansible and contractible building drum 3. It will be noted that in Fig. 2, as was discussed with regard to Fig. 1A, the cap band 19 of the instant invention is made up of a plurality of helical windings of undulating cord tapes 17.

Turning now to Figs. 2A and 2B it will be seen that these figures illustrate modifications or alternative embodiments of the tire carcass illustrated in Figs. 1, 1A and 2. Thus, Figs. 1, 1A and 2 illustrate a cap band 19 having an axial width less than that of the breaker 17. Fig. 2A, however, illustrates a cap band 19 having an axial width substantially equal to the axial width of the widest of the breaker plies 13 and 15 comprising the breaker 16. In this regard it is appropriate to note that although each of the figures herein illustrates a breaker structure comprised of breaker plies which are of progressively narrower axial width in the radially outward direction, i.e., the axial width of ply 15 is less than that of ply 13, the tire may also be constructed with breaker plies each having the same axial width as well as with breaker which are progressively axially wider in the radially outward direction. Fig. 2B illustrates an embodiment of the invention in which the cap band 19 has an axial width greater than the axial width of the axially widest breaker ply of the breaker 16. This structure may advantageously be utilized in tires intended for use at high speeds for the reasons previously discussed.

Turning now to Fig. 4 there is shown a partially sectioned perspective view of the cured, toroidally shaped, complete tire 33 made according to the method of the present invention. The diameter of the toroidally shaped completed tire, in the crown region thereof, is approximately 1:59 times as great as the diameter of the cylindrically shaped tire carcass 1 illustrated in Fig. 1. In general, however, the diameter of a completed tire, in the crown region thereof, will be between 35% and 70% geater than the diameter of the corresponding raw tire carcass.

The angle made by the breaker tire cords of the completed tire relative to the crown cetnerline or median equatorial plane (indicated at X—Y) of the completed tire 33 is approximately 25°—30°, whereas the angle the breaker tire cords made with the plane orthogonal to the axis A—B of drum 1 was, in the embodiment illustrated in Fig. 1, indicated to be about 40°. It therefore may be seen that the breaker tire cords pantographed during the aforementioned shaping. In general the breaker tire cords will pantograph down during the shaping from between 30° and 70° with the plane orthogonal to the axis A—B of the drum 3 to an angle of between 20° and 60° with the crown centerline of the completed tire 33.

WHAT WE CLAIM IS:—

1. A method for making a radial ply tire in a single building stage, comprising winding at least one ply of body tire cords around a tire building drum to form a cylindrically shaped body with said body tire cords extending substantially parallel to the axis of said drum; serially wrapping an even number of plies of bias angled breaker tire cords around the radially outer surface of said body to form a breaker, the breaker tire cords in each ply being parallel, and the cords being oppositely disposed in adjacent plies and forming an angle of between 30° and 70° with the plane orthogonal to the axis of said drum; helically winding a "soft-stretch" reinforcing cord tape (as herein defined) around the radially outer surface of said breaker for at least a selected plurality of full turns to form a cap band having a desired axial width, said tape being wound at an angle of substantially 0° relative to the plane orthogontal to the axis of said drum; and wrapping tread and sidewall rubber around the radially outer surface of said cap band and the lateral regions of said body so as to provide a raw, cylindrically shaped, tire carcass having a diameter which is substantially less than the diameter of the crown region of the corresponding cured, toroidally shaped completed tire.

2. A method according to claim 1, and including the step of simultaneously shaping and curing said raw cylindrically shaped carcass to form said completed tire.

3. A method according to claim 1 or claim 2, in which the diameter of the crown region of said completed tire is between 35% and 70% greater than the diameter of the raw tire carcass.

4. A method according to any one of the preceding claims, in which the axial width of said cap band is less than the axial width of said breaker.

5. A method according to any one of claims 1 to 3 in which the axial width of said cap band is equal to the axial width of said breaker.

6. A method according to any one of claims 1 to 3 in which the axial width of said cap band is greater than the axial width of said breaker.

7. A method according to any one of claims 1 to 6 in which the breaker tire cords form an angle of between 40° and 70 with the plane orthogonal to the axis of the drum.

8. A method according to claim 2, in which said breaker tire cords pantograph during said shaping to ultimately form an angle of from 20° to 60° with the crown centerline of said completed tire.

9. A method according to any one of the preceding claims in which said "soft-

stretch" reinforcing cord tape includes a plurality of substantially inextensible cords disposed in side by side relation with one another.

10. A method according to claim 9, in which said tape includes six substantially inextensible cords disposed in side by side relation with one another.

11. A method according to any one of the preceding claims in which the tape is longitudinally extensible by from 20% to 400% without stretching the cords thereof.

12. A method according to any one of the preceding claims in which the tape is longitudinally extensible by from 30% to 90% without stretching the cords thereof.

13. A method according to any one of the preceding claims in which the tape is longitudinally extensible by from 30% to 75% without stretching the cords thereof.

14. A method according to any one of the preceding claims in which said tape is so wound around said breaker as to provide an axially extending gap or up to three-quarters of one inch between adjacent turns of said tape.

15. A method according to any one of the preceding claims in which said breaker tire cords are steel.

16. A method for making a radial ply tire in a single stage, substantially as herein described with reference to the accompanying drawings.

17. As an intermediate article of manufacture, an uncured, radial ply tire carcass in the as drum-built form thereof, comprising a cylindrically shaped body including at least one ply of body tire cords, which tire cords extend substantially parallel to the axis of said cylindrically shaped body; a breaker positioned circumferentially about said body, said breaker including an even number of plies of bias angled breaker tire cords, said breaker tire cords in each ply being parallel and the cords being oppositely disposed in adjacent plies and forming an angle of from 30° to 70° with the plane orthogonal to the axis of said cylindrically shaped body; a cap band positioned circumferentially about said breaker, said cap band being formed by "soft-stretch" reinforcing cord tape (as herein defined) helically wound around the radially outer surface of said breaker for at least a selected plurality of full turns, said tape being wound at an angle of substantially 0° relative to the plane orthogonal to the axis of said cylindrically shaped body; and tread and sidewall rubber positioned circumferentially about said cap band and the lateral regions of said body.

18. An article according to claim 17, in which said breaker tire cords are steel.

19. An article according to claim 17 or claim 18 in which the breaker tire cords form an angle of between 40° and 70° with the plane orthogonal to the axis of the drum.

20. An article according to any one of claims 17 to 19 in which the axial width of said cap band is less than the axial width of said breaker.

21. An article according to any one of claims 17 to 19 in which the axial width of said cap band is equal to the axial width of said breaker.

22. An article according to any one of claims 17 to 19 in which the axial width of said cap band is greater than the axial width of said breaker.

23. An article according to any one of claims 17 to 22 in which said "soft-stretch" reinforcing cord tape comprises a plurality of substantially inextensible cords in side by side relation with one another.

24. An article according to claim 23 in which said tape comprises six substantially inextensible cords disposed in side by side relation with one another.

25. An article according to any one of claims 17 to 24 in which the tape is longitudinally extensible by from 20% to 400% without stretching the cords thereof.

26. An article according to any one of claims 17 to 24 in which the tape is longitudinally extensible by from 30% to 90% without stretching the cords thereof.

27. An article according to any one of claims 17 to 24 in which the tape is longitudinally extensible by from 30% to 75% without stretching the cords thereof.

28. An article according to any one of claims 17 to 27 in which each of the turns of said tape is spaced from each adjacent turn to form a plurality of axially extending gaps in said cap band, each of said gaps being up to three-quarters of one inch wide.

29. As an intermediate article of manufacture, an unaired, as drum-built, radial ply tire carcass substantially as herein described with reference to the accompanying drawings.

30. A pneumatic tire made by a method including the steps of any one of claims 1 to 16.

31. A pneumatic tire made from an intermediate article according to any one of claims 17 to 29.

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1569640 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

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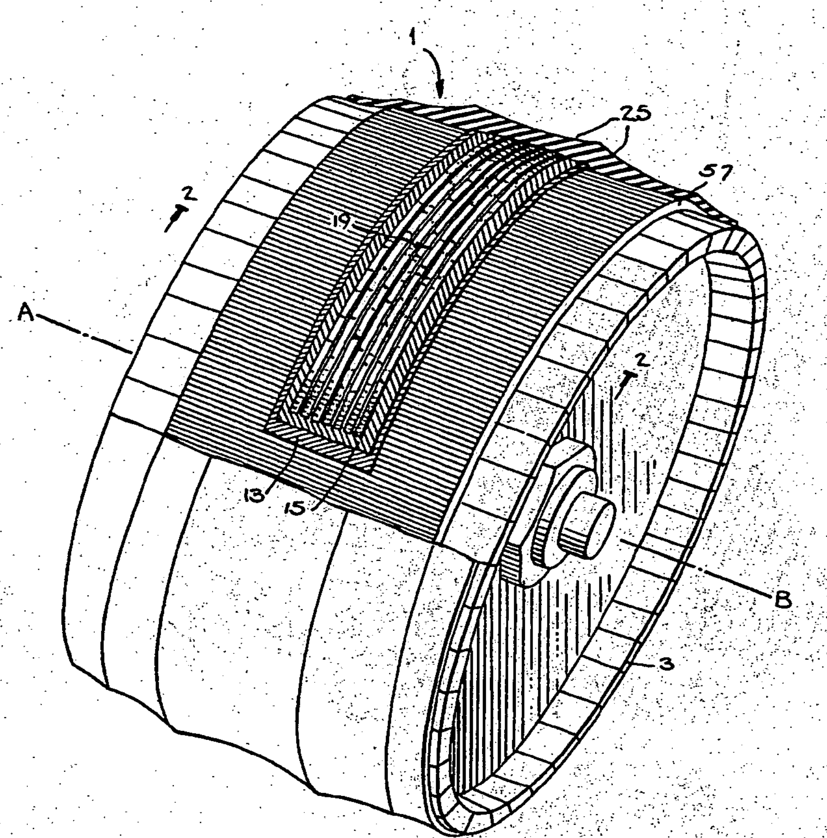

Fig.1.

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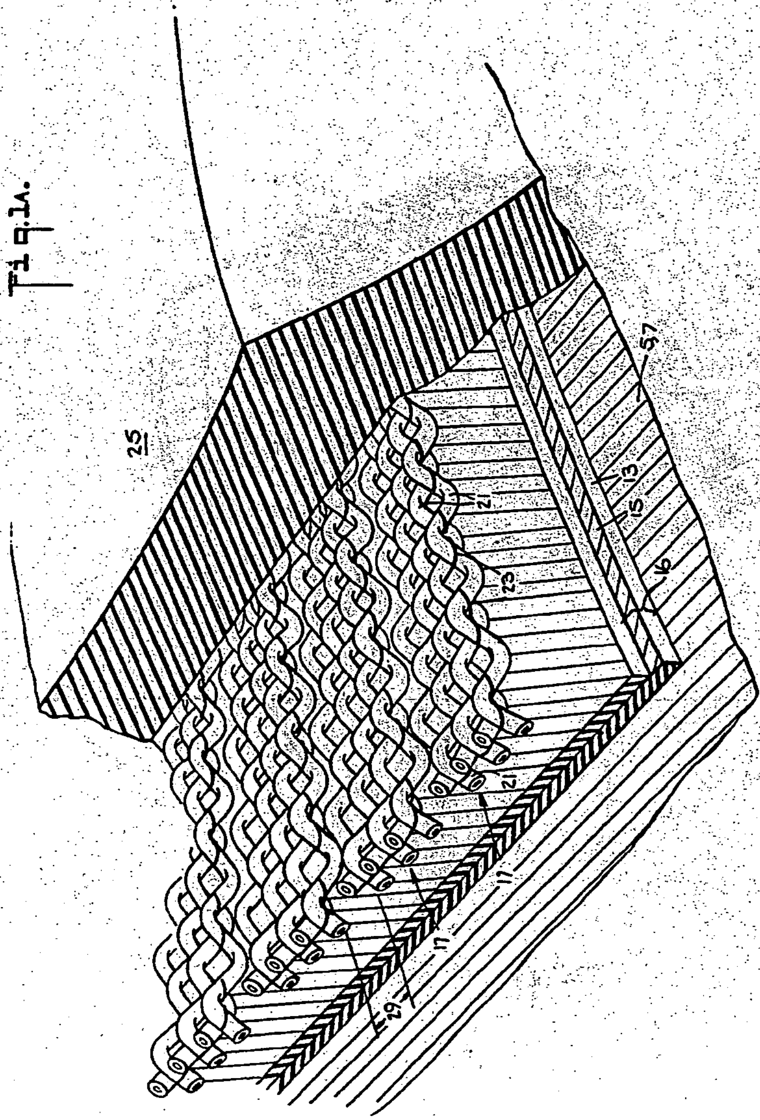
Sheet 2

Fig.1A.



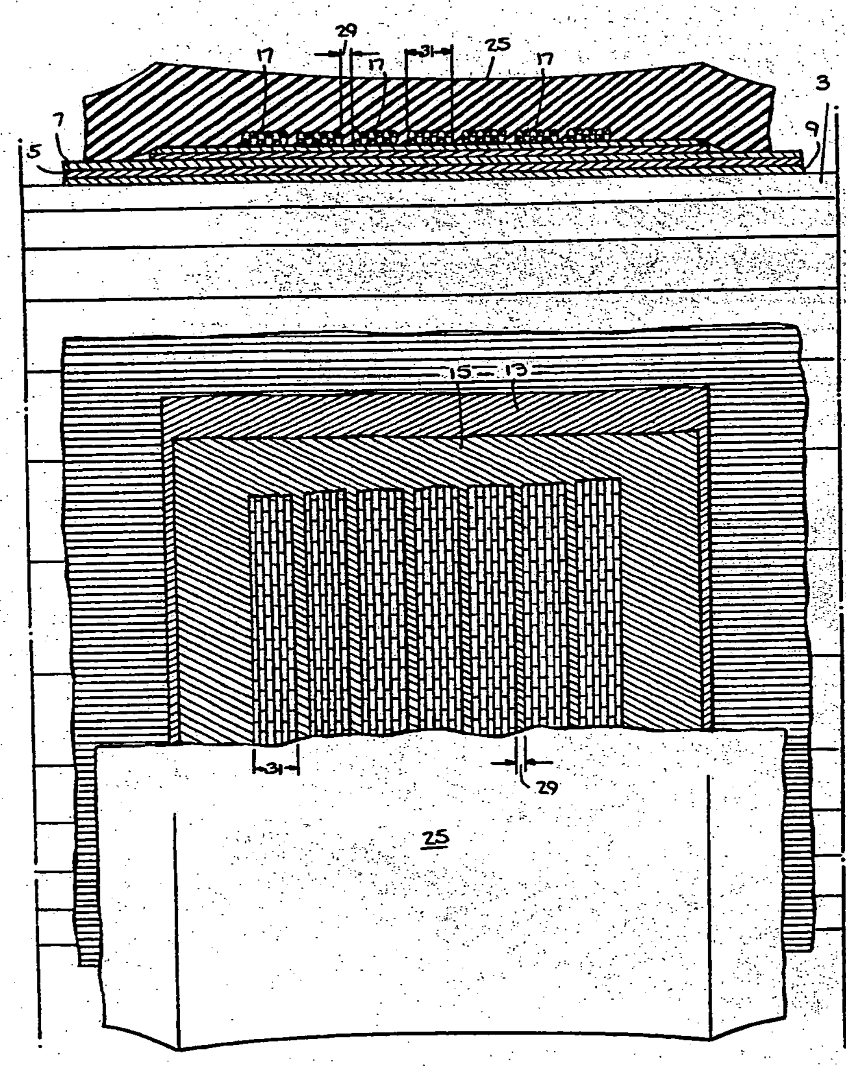
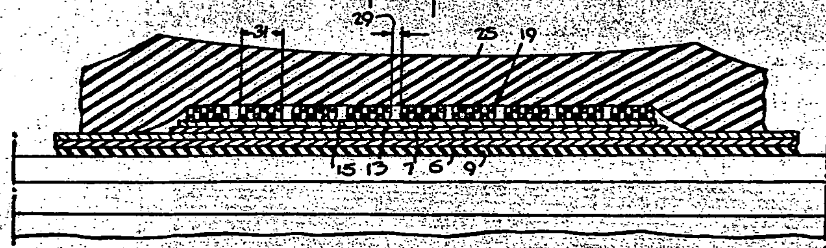


Fig.2.

Fig.2A.



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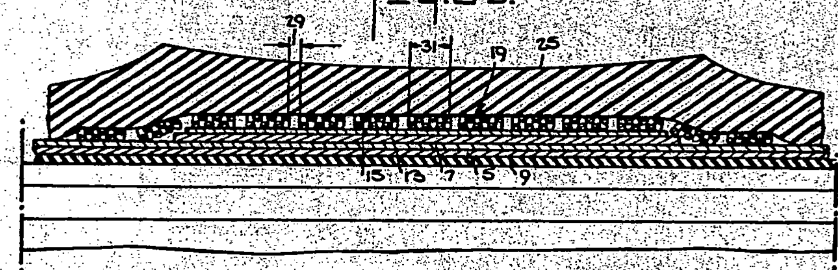
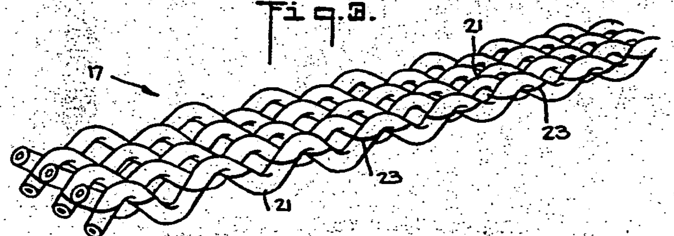


Fig.3.



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Sheet 5

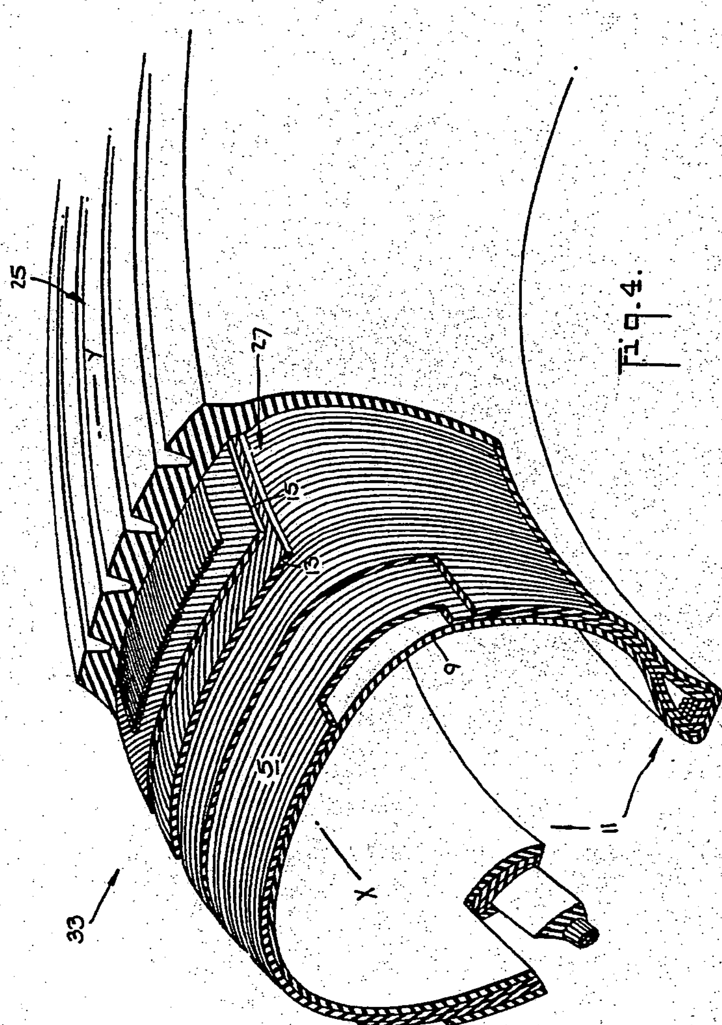

Fig. 4.